founded with the special aim of fostering the industrial arts, should be to insist on teaching *principles* systematically, and not in their isolated applications. To treat of the applications of the science is, of course, necessary, even for the sake of science itself; and under certain circumstances, some of these applications may wisely be dwelt on more than others; but this is quite a different thing from pretending to teach as *science* detached *fragments* of science in their application to this or that art.

The following extract from a well-known essay by Liebig, written so long ago as 1840, clearly shows that his views on this question coincide with those above expressed:—

"The teaching of science in the laboratories of the Trade—and Polytechnic—Schools is, in most places (in Prussia), very deficient. A system of true scientific instruction should fit a student for each and every possible application of science; for these applications become easy, and follow as a matter of course, from a knowledge of scientific principles. Nothing is more deleterious or dangerous than when utilitarianism is made the foundation of a system of tuition in a school, or when institutions, whose true aim ought to be experimental instruction in scientific principles, are employed to convert mere children into soap-boilers, brandy-distillers, or sulphuric acid makers. All this entirely destroys the true purpose of the institution.

"I have found, in all those attending my laboratory who intended to pursue a technical course of study, a general predisposition to devote themselves to some branch of applied chemistry. It is only with feelings of fear and trepidation that they consent to follow my advice, and give up the time they thus waste on mere drudgery to making themselves acquainted with the methods by which pure scientific problems are soluble, and by which alone they can be solved. . . . . There are many of my pupils, now at the head of many departments of manufacturing industry, who, having had no previous acquaintance with the processes, were in half an hour perfectly *au fait* with all the details of the manufacture, whilst in a short time they saw and introduced all sorts of necessary reforms and improvements. This power they had gained by being accustomed in their laboratory work to obtain the most accurate and precise knowledge of all the substances which came into their hands in their work; they had to learn the conditions necessary for avoiding errors, they investigated the properties of the products of decomposition formed, and thus became acquainted with the sources of error, with the means of avoiding losses; they were able to improve their apparatus, and to amend their processes. All this can never be learnt when the work is conducted according to cut-and-dry methods."

There are, no doubt, certain obstacles in the way of the proposed amalgamation in Germany; but in the old English Universities, and in the science colleges which we hope soon to see established in various parts of England, the difficulty would not arise at all. Apart from questions of tradition and historical routine, there can be no reason why students of applied science, led by their probable destination to manufacturing industry, should not study systematic science in the same class-rooms with students of the same subject who may have other aims: and if such students require minute practical and experimental instruction, there is no reason why they should not obtain this in physical and mechanical, as they do already in chemical, laboratories. In such a technical department, future teachers of science and leaders of manufacturing industry would be trained in the application of science to the most important branches of art and manufacture—so far, that is, as these are fit subjects for academic treatment; so far as they are not, they must be left to the workshop.

H. E. ROSCOE

VON SCHLICHT ON FORAMINIFERA

Die Foraminiferen des Septarienthones von Pietzpuhl. By E. von Schlicht. 4to. With 38 lithographic plates. (Berlin, 1870. London: Williams and Norgate.)

SINCE the appearance of D'Orbigny's "Foraminifères Fossiles du Bassin Tertiaire de Vienne," no work has been issued on the Foraminifera in their geological or palæontological relations, with pretensions at all corresponding to those of the newly-published monograph, the title of which stands at the head of the present article. We do not use the word *pretensions* in an offensive sense, for the author is careful to apprise his readers of the limitations of the treatise; but rather to indicate the sort of impression produced by the dimensions of the book and its profuse illustration. A quarto volume containing, in addition to the letter-press, thirty-eight large plates devoted to the Foraminifera of a small division of the Tertiary system of North Germany, and confined to a very limited district, or, as we might put it, 1,192 drawings of microscopic shells from the clay of a single brickyard, ought to show in its results a very evident *raison d'être* to save it from the imputation of labour thrown away. We need not require the expression of new or startling philosophical views to bring such a work within the scope of things worth doing; but we may fairly expect from so large an expenditure of labour and cost, some real and definite addition to our scientific knowledge. Whilst a smaller book might pass unnoticed, or at least without critical examination, one like this cannot escape without an inquiry as to what it contains of novelty, either in observation or theory,—in facts or their arrangement; and on the reply dictated by a patient study of its contents, the verdict as to its value must depend. To frame an answer to these questions which will serve to give an idea of the work, it will be necessary to offer a few preliminary observations and to epitomise the labours of previous observers in the same field.

In the Tertiary system of Belgium, and Northern and Central Germany, there occurs a thick bed of clay, containing nodules of argillaceous limestone, with radiating cracks or fissures in their interior, which have become filled with calc-spar. These nodules are termed "septaria," and they are regarded as sufficiently characteristic of the deposit to give it a name, though possibly a somewhat indefinite one. As used by German authors, the term "Septarienthon" includes the Rupelian clays of Rupelmonde and Boom, near Antwerp, the brick-clays of the neighbourhood of Berlin, together with similar beds in the valleys of the Maine and Elbe, and in many other localities between the Baltic and the centre of Germany. These beds are of Lower Miocene or Upper Eocene age, and belong to a group of transition strata, associated by continental geologists under the name "Oligocene," which are scarcely represented in Great Britain. Possibly the fluvio-marine beds of the Isle of Wight are the nearest equivalent to be found in the Tertiaries of this country.[*]

The exact geological position of the Septaria-clay is of less consequence to our present purpose than the general fact that it was deposited some time during that earlier or middle Tertiary period in which the Foraminifera, as a zoological group, had their most conspicuous development. It is not surprising that so promising a field should have been diligently worked by German rhizopodists, and it may be questioned whether any single bed, or group of beds, has received so large an amount of attention in respect to its microzoa. The particular locality to which Herr von Schlicht's researches refer, is the estate or manor of Pietzpuhl, which lies at the highest point of a Tertiary ridge, commencing at the river Elbe, a little north of Magdeburg, and extending in an easterly direction above Möckern to Loburg,—a course of eighteen or twenty English miles. The clay-bed is worked at Pietzpuhl for bricks or some other economical purpose, and being open to-day, the investigation of its fossil fauna presents no preliminary difficulties.

Attention was first directed to the microzoa of the Septaria-clay just twenty years ago, in two letters from Herr Reuss (then of Bilin) to Herr Beyrich, on "Foraminifera in Clay, from Hermsdorf,"[†] which appeared in the Journal of the German Geological Society. These communications contained little beyond a list of the genera represented; but a year later, a third letter was published,[‡] containing a good deal of supplementary information, and in 1851 Professor Reuss published a more elaborate paper "On the Fossil Foraminifera and Entomostraca of the Septaria-clays of the neighbourhood of Berlin,"[§] containing the results of the examination of the beds described by Prof. Beyrich, together with a tabular comparison of the species obtained at Hermsdorf and Freienwalde with those of other well-known Tertiary deposits, such as the Miocene of the Vienna Basin and the sub-Appenine Pliocene clays. The table presents a series of sixty-five species, and of these, fifty-three are described and figured as "new." All except four of them were obtained from Hermsdorf. We will not enter into any analysis of the catalogue, else we might be tempted to exceed our bounds, in criticism on the new species.

Another letter from Prof. Reuss[‖] gave similar particulars respecting two fresh localities, viz:—Gorzig near Köthen, and the excavations of Fort Leopold at Stettin. Shortly afterwards, appeared an elaborate paper by Dr. J. C. Bornemann of Leipsic on the "Microscopical Fauna of the Septaria-clay of Hermsdorf, near Berlin[**] containing much of novelty and interest, and adding forty-six more "new species" of Foraminifera to an already extensive list. The figures of many of these show curious modifications of the simpler types, those of the genus *Polymorphina* being especially instructive. In 1858 Prof. Reuss contributed a further instalment to the literature of the subject in his paper "On the Foraminifera of Pietzpuhl,"[††] and this concerns our present purpose more directly, as it is stated to be the first result of the author's examination of the specimens in Herr von Schlicht's collection. It is, however, little more than a catalogue, and introduces by name seventy-two more "new species," without either figures or descriptions.

Six years later Prof. Reuss published in the Reports of the Vienna Academy his researches "On the Foraminifera of the Septaria-clay of Offenbach"[*] near Frankfort, figuring therein forty-four more new species; and finally, in 1866, amongst the memoirs presented to the same scientific body appears an elaborate monograph by Prof. Reuss, entitled "The Foraminifera, Anthozoa, and Bryozoa of the German Septaria-beds,"[†] one of the most instructive, as well as one of the most beautifully illustrated of the author's many contributions to the history of the fossil Protozoa and Cœlenterata. This paper is not devoted, like its predecessors, to the description of new species, but is rather an epitome of the facts already known, with additional information as to distribution. It is supplemented by a comparative table of the geological and geographical relations of 228 reputed species, which is a sort of concentrated essence of the whole. Without compromising our radical objection to the system of sub-dividing and re-naming, time after time, forms having the same essential characters, on account of minute and very variable peculiarities, or of regarding a slight difference in geological age as a reason for constituting a new species in cases where zoological characters fail to show ground of distinction, we may cheerfully yield to Prof. Reuss our tribute of admiration for his final summary of what was known of the microzoa of the Septaria-clay.

These bibliographical details have appeared necessary because the field of research to which they refer is one with which British palæontologists have little opportunity of becoming practically acquainted; and our object in respect to Herr von Schlicht's work is half accomplished now that we have indicated the amount of labour previously expended on the same subject.

Herr von Schlicht introduces his monograph by a preface of seven pages, comprising the readable matter of the volume. This introductory essay deals in generalities rather than new truths, and the apology of the author constitutes its chief novelty. After a few preliminary paragraphs he mourns the shortcomings of the work in respect to classification, nomenclature, and other important matters. Of the systems of classification, Prof. Reuss's, as last amended, is alone spoken of with much commendation; that of Prof. Max Schultze receives bare mention, as do also the views of British rhizopodists. "After all," asks the author, "do we know enough yet about the Foraminifera to invent any classification of them? Some people think not; and so, on the whole, although the early D'Orbignyan arrangement is the worst, it is pretty well known, and it will be the least trouble."

It may be that the systematic scheme laid down by Prof. Reuss is faulty: in this we should agree with Herr von Schlicht, though on different grounds; but it has a basis of natural relationship in its larger groups, wholly wanting in that of D'Orbigny. That a general harmony should exist between its sub-divisions and those indicated by the independent researches of Dr. Carpenter and his colleagues in this country, is surely strong evidence in its favour; and the fact of its having been used in the latest publications on the particular subject of the work, gave it a strong claim for introduction, in spite of the alleged possibility of subsequent modification.

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[*] See a paper by Sir Charles Lyell, on the Belgian Tertiaries. *Quart. Journ. Geol. Soc.*, vol. viii. p. 299.

[†] *Zeitschrift d. deutsch. geol. Gesellsch.*, vol. i. p. 259.

[‡] *Ib.* vol. ii. p. 49.

[§] *Ib.* vol. iii. p. 309.

[‖] *Ib.* vol. iv. p. 16.

[**] *Ib.* vol. vii. p. 307.

[††] *Ib.* vol. x.

[*] *Sitzungsberichte der k.k. Akademie der Wissenschaften*, vol. xlviii.

[†] *Denkschrift der math.-naturwissen. Cl. der k.k. Akad. Wissensch.* vol. xxv.

The author further laments the imperfection caused by his omission of specific or trivial names. In the prospect of a new and better classification, with the possible employment of different criteria for the separation of genera and species, every new specific name would, he thinks, only serve to increase the present confusion in nomenclature, and to augment the difficulties of future observers; besides, hints the author shrewdly, "thereby I have spared to myself a notable piece of labour." So the honour of appending specific names is willingly bequeathed to the future systematist who shall investigate the new forms, and who, we agree with Herr von Schlicht, will not be overpaid for his trouble.

Thus we are warned at the outset that, so far as nomenclature is concerned, no advantage is taken of the mass of plates which occupies half the volume. And yet, oddly enough, the author does name *one* of his figures—an attenuated, slightly curved, costate Nodosarian, with broad, clear, somewhat irregular sutures and pointed ends. This he calls *Dentalina edelina n.s.*, a name that might very well have been spared.

Notwithstanding the absence of trivial names, *genera* are recognised, and detailed descriptions are given of the specimens figured, with references to the plates. Thirty-two genera are adopted (two of them new), and *numbers* from 1 to 556, are appended to the descriptions instead of *names*. Some of the old generic terms employed are already regarded as untenable by those who had been in the habit of using them, and the two new ones are certainly needless. One of them, "*Atractolina*," represents a mixed lot of forms, some of them possibly compact fusiform *Polymorphinæ*, the remainder doubtful *Nodosarinæ*. In the case of two generic types which inosculate in their feebler varieties, as these most certainly do, we are ready to admit the difficulty of determining to which group a number of the intermediate forms belong; but to make a fresh sub-division for them cuts the knot rather than unties it. The other new genus, "*Rostrolina*," has no better foundation, based as it is on the mere shape of the terminal orifice—a straight or curved slit in the mucronate terminal chamber, instead of the circular or radiate aperture usually found. Specimens with this peculiarity have long been known, but have been regarded as mere individual modifications, and no previous writer has thought it necessary to invent even a specific name for them.

A good deal of criticism might be expended on the subdivisions and their arrangement, but we content ourselves with the passing remark that Reuss's type *Chilostomella* is out of place amongst the *Polymorphinidæ*, and that *Bolivina* is far separated by the author from *Bulimina*, which is its nearest ally.

We may sum up in a few sentences. Notwithstanding the work falls far short of what it might have been in many important particulars, it is of considerable value. The omission of any attempt to simplify the nomenclature, with the opportunity the large number of plates offered for doing so excellent a service, is inexcusable. It may be doubted whether a single new specific name would have been needed, and the plates might have been made the basis of a large reduction in those already in use. The best point of all about the book is the completeness of many of the series represented,—the consecutive links in the chain between a number of reputed species being in many cases all figured. It more than once occurred to us in turning over the plates, there must be something of dry humour about an author who could suggest that anyone who named the new forms would deserve all the honour he could get out of them, and that the fasciculus of plates was intended to demonstrate that the system of species-splitting could not be carried further than it had been carried by some previous authors, short of naming every specimen. On the other hand, from the large number of drawings devoted to the illustration of the minute morphological variations of a few simple types, the work affords valuable testimony to the truth of the views enunciated by Mr. W. K. Parker in his earliest paper on the Miliolitidæ of the Indian Seas, as to the impossibility of sub-dividing these lowest classes of animals by hard lines corresponding to the specific limits of more highly organised creatures; that a long series of forms presenting an extraordinary range of morphological variation may be grouped round sub-types, several of which merging at their edges into each other, and without any perceptible lines of demarcation between them, find in their turn a common central type, and that this type more nearly than any minor division represents what we are accustomed to term a species. If we regard Herr von Schlicht's volume from this point of view, we may easily see how it may possess considerable value, though not exactly of the sort that was intended by its author.

We should just add, that though the paper and letterpress are excellent, the plates are scarcely equal in solidity and clearness to the lithographic work we have been accustomed to see in German memoirs on the Foraminifera.

H. B. BRADY

ENCKE THE ASTRONOMER

Johann Franz Encke: sein Leben und Wirken. Von. Dr. C. Bruhns. (Leipzig, 1869. London: Williams and Norgate.)

FOUR years have passed since Encke died. Even those four years have witnessed notable changes in the aspect of the science he loved so well. But we must look back over more than fifty years if we would form an estimate of the position of astronomy when Encke's most notable work was achieved. At Seeberge under Lindenau, Encke had been perfecting himself in the higher branches of mathematical calculation. He took the difficult work of determining the orbital motions of newly discovered comets under his special charge, and Dr. Bruhns tells us that every comet which was detected during Encke's stay at Seeberge was subjected to rigid scrutiny by the indefatigable mathematician. Before long a discovery of the utmost importance rewarded his persevering labours. Pons had detected on November 26, 1818, a comet of no very brilliant aspect, which was watched first at Marseilles, and then at Mannheim, until the 29th December. Encke next took up the work and tracked the comet until January 12. Combining the observations made between